

Bowing of a Pipeline from Longitudinal Compressive Stress Induced by Ground Movement

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Abstract : This paper concerns a case of a 10.75 inch diameter buried gas transmission line which was exposed to mine subsidence ground movements. The pipeline was buried about 4ft. below the surface with maximum operating pressure of 1440 psi. The mine subsidence movement was the result of long walling ore at a depth of approximately 1600 ft. As ore extraction progressed, the stress in the monitored pipeline worsened and was approaching unacceptable levels. The excessive pipe compression resulted when it was exposed to the compression zone of subsidence basin created by mining. The pipe stress reached a significant compressive level due to the extensive length of the pipe exposed to frictional ground-pipe slip resistance. The backfill ground movement slip resistance depends on normal stress around the pipe, the rate of slip, and the backfill characteristics. Normal stress depends on the burial depth of the backfill density and the lateral subsidence induced stress. The backfill in this site has a soil dry density of approximately 90 PCF. A suite of direct shear tests was conducted a residual friction angle of 36° was determined for the ambient backfill. These tests showed that the residual shearing resistance was reached within a fraction of an inch. The pipe was coated with fusion-bonded epoxy, so friction reduce factory of 0.6 can be considered. To relieve ground movement induced compressive stress, the line was uncovered. As more of the pipeline was exposed, the pipe abruptly bowed in the excavation. An analysis of this pipe formation which was performed is provided in this paper. Also discussed in this paper are ways to mitigate this pipe deformation or upheaval buckling from occurring. Keywords: Pipe Upheaval, Pipe Buckling, Ground subsidence, Buried Pipeline, Pipe Stress Mitigation.

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